REMARKS/ARGUMENTS

1. This amendment is filed in response to the office action having a mailing date of May 12, 2009. Applicant respectfully submits that the following remarks are fully responsive to the official communication. Claim 1 is amended. Claims 2-4 are canceled. Claims 5-20 are new dependent claims. Language associated with the proposed claims has been added to the specification.

2. Office Action Page 2 "Information Disclosure Statement." With respect to the "Supplemental Disclosure Statement," the examiner indicates that Document 17 (JP 64-071399) and Document 21 (WIPO 2004/013977) are not present in the file. Although, the undersigned's records indicate that both were originally filed, these documents are attached hereto with an explanatory cover sheet.

With respect to the "Third Supplemental Information Disclosure Statement," the examiner has requested an English translation of the abstract for Document 28 (CN2070556U). This document is attached with an explanatory cover sheet. The examiner also requested an English translation of the abstract for Document 27 (CN86108791A). Although such a translation is not available, the applicant has attached WO8703501, which is the English language corresponding PCT application.

3. Office Action Page 2 "Claim Objections" and "Specification." The applicant proposes to cancel claim 3 in answer to the claim and specification objections on page 2 of the Office Action.

4. Office Action Page 3 "Claim Rejections – 35 USC Sect. 112." On page 3 of the Office Action, the Examiner has alleged that it is not clear what is meant by "rear" within claim 1. We now propose amending claim 1 to define that the microphone and speaker enclosure are placed against a rearward portion of the wearer's head. We submit that the term "rearward" is clear and would encompass any region behind the center of the wearer's head, for example as depicted in Figure 9 of the present patent specification.

5. Office Action Page 4 "Claim Rejections – 35 USC Sect. 102." Turning to page 4 of the Office Action, the Examiner has rejected claims 1, 2, and 4 as being anticipated by Locarno et al (US 6,298,249). Applicant proposes amending claim 1 to further distinguish the present invention from Locarno. Applicant also proposes canceling dependent claims 2 to 4 and further including dependent claims 5 to 20. The claims on file now correspond to those granted in relation to granted New Zealand Patent 539250, against which Locarno was also cited, with the exception of the amendment to claim 1 whereby "including" is replaced by "comprising".

Claim 1 now recites "a vibration conduction speaker enclosure including a speaker and arranged to couple vibrations from the speaker to bone of a wearer". This feature is plainly not disclosed in Locarno, which instead relates to a conventional air conduction speaker.

6. Office Action Page 5 "Claim Rejections – 35 USC Sect. 103." Although claim 3 has been canceled, the following is considered pertinent.

MPEP 2143.01 states that "The test for obviousness is what the combined teachings of the references would have suggested to one of ordinary skill in the art, and all teachings in the prior art **must** be considered to the extent that they are analogous arts".

The present invention lies in the art of bone conduction speakers. In contrast, the invention of Locarno lies in the unrelated art of conventional acoustic air conduction. A person skilled in the specialized art of bone conduction speakers would not look to the field of conventional acoustic air conduction speakers to solve the technical problem faced by the present inventor. That is because the technical problem faced by the inventor involves coupling sound vibrations to a wearer's skull bone whereas conventional speaker's couple sounds to air.

Accordingly, it is submitted that Locarno is non-analogous and is therefore not pertinent.

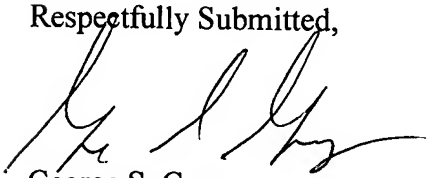
Nevertheless, even if Locarno were analogous prior art, which is denied, the presently claimed invention is non-obvious over Locarno for the following reasons.

A problem that the inventor addressed by conceiving of the bone conduction speaker of the present invention is described toward the end of paragraph [0002] of the publication of the present application (Pat Publ. No. US 2006/0227982). That problem is that "*Other approaches to facilitating communication have involved the use of headphones which cover the ears. While such an approach allows the wearer to readily hear sound from the headphones it prevents the wearer from hearing ambient noise and engaging in direct communication with those nearby.*" The use of a bone conduction speaker, according to the presently claimed invention, allows for the speaker to be positioned so that it does not obstruct the wearer's ear. This in turn allows the wearer to hear both normally through the ear and also to hear communications via the bone conduction speaker.

Neither the above problem, nor the presently claimed solution, are described in Locarno. Consequently, applicant submits that the attached claims are non-obvious.

7. Applicant respectfully submits that all of the Examiner's objections have been successfully traversed. Accordingly, it is submitted tha the application is now in condition for allowance. Reconsideration and allowance of the application are requested.

Respectfully Submitted,



George S. Gray
Reg. No. 37,140
361-232-7092

Date: October 12, 2009

ENGLISH ABSTRACT TRANSLATION FOR THIRD SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT RE DOCUMENT NUMBERED 28 THEREIN

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 64-071399

(43)Date of publication of application : 16.03.1989

(51)Int.Cl. H04R 1/00

(21)Application number : 62-228704

(22)Date of filing : 11.09.1987

(71)Applicant : MEISEI ELECTRIC CO LTD

(72)Inventor : YAMAZAKI SHIGEO

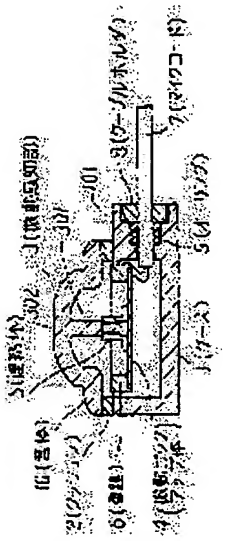
NAGAYAMA HIROSHI

(54) BONE-CONDITION MICROPHONE

(57)Abstract:

PURPOSE: To easily mount the titled microphone without a special outfit by constituting it so that a vibration pick-up body may be fitted in a suspended condition in a space around a vibration sensing part.

CONSTITUTION: An spindle body 301 is provided at the center part of a vibration sensing part 3, and a linking body 5 stuck and fixed at the center of a vibration pick-up body 4 is screwed and fixed at the tip of the spindle body 301. Thus, the pick-up body 4 is supported in the suspended condition in the internal space of a case 1. The bone-conduction microphone with such a constitution is fitted at the inner surface of a helmet, and when a diver puts on the helmet, the sensing part 3 contacts with the head at a suitable contact pressure. When the diver utters a voice, the vibration generated in the skull of the diver is sensed by the sensing part 3, transmitted through the spindle body 301 and the linking body 5 to the pick-up body 4, and outputted to a mike code 7.



RESUBMITTAL OF DOCUMENT 17 IN THE SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT FILED APRIL 25, 2007

PATENT ABSTRACTS OF JAPAN

(11) Publication number : 64-071399
(43) Date of publication of application : 16.03.1989

(51) Int. Cl. H04R 1/00

(21) Application number : 62-228704
(22) Date of filing : 11.09.1987

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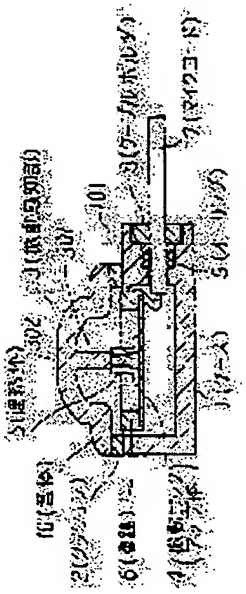

LEGAL STATUS

Date of re uest for examination

Date of sending the examiner s decision of re ection

ind of final disposal of application other than the examiner s decision of re ection or application converted registration

Date of final disposal for application

Patent number

Date of registration

Number of appeal against examiner s decision of re ection

Date of re uesting appeal against examiner s decision of re ection

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60/399,699 1 August 2002 (01.08.2002) US

(71) Applicant: VIRGINIA COMMONWEALTH UNIVERSITY [US/US]; 800 E. Leigh Street, Suite 113, Richmond, VA 23219 (US).

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(74) Agents: WHITHAM, Michael, E. et al.; Whitham, Curtis & Christofferson, P.C., Suite 340, 11491 Sunset Hills Road, Suite 340, Reston, VA 20190 (US).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW.

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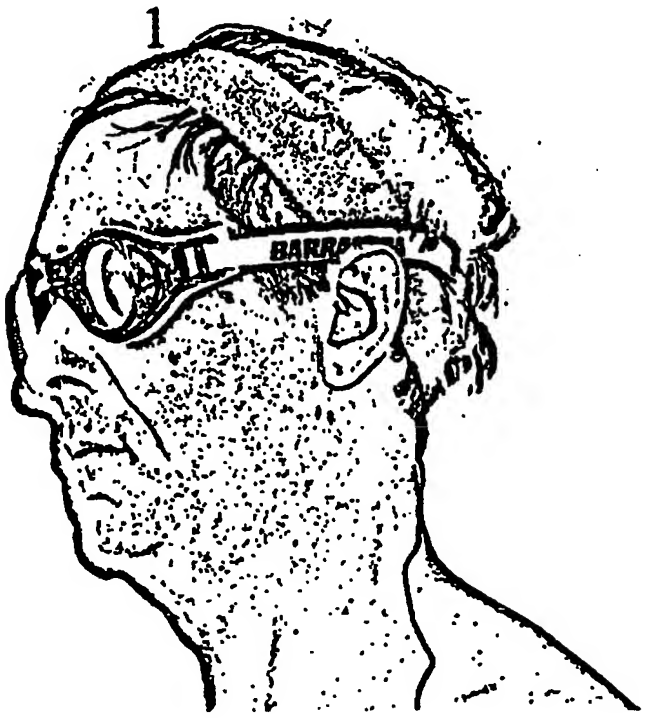
Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: RECREATIONAL BONE CONDUCTION AUDIO DEVICE, SYSTEM



(57) Abstract: A waterproof recreational audio device and method that transmits sound via transcutaneous bone conduction provides high fidelity musical signals to a user. The device can be worn on the head of a user and integrated into various types of headgear. The device is tunable for sound quality and comfort by adjusting and moving the sound transmitting transducers around the head of the user. The present invention uses commercially available transducers to produce sounds in the low, mid and high frequency ranges. A sound source for the musical signal can also be provided as part of the waterproof recreational audio device. Controls enable the user to select volume levels for the high, mid and low frequency ranges, while a volume limiter restricts the mid range to a preset maximum volume level to allow external ambient sounds to be heard via the ear canal and protects the hearing of the user.

WO 2004/013977 A2

RECREATIONAL BONE CONDUCTION AUDIO DEVICE, SYSTEM

DESCRIPTION

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention generally relates to waterproof recreational audio devices and, more particularly, to recreational audio devices that provide high quality musical sound to users through bone conduction sound transmission and the methods related thereto.

Background Description

Since the introduction of the Sony Walkman in July of 1979, over 100 million units have been sold. The Oxford English Dictionary certified 'walkman' as a noun in 1986 describing it as a personal audio device. The recreational audio device has established itself as a mainstay for personal music enjoyment. Advances in the personal audio device market have typically been focused in two areas: size of the unit and headphone improvements. Headphones for personal audio systems have historically been air conduction systems that rely on tympanic hearing for sound transmission.

In tympanic hearing, sound travels through the ear canal to the eardrum making it vibrate. These vibrations are passed to three small bones in the middle ear, the ossicles, by a process called air conduction. These in turn pass the vibrations to the cochlea and the fluid it contains. Movement in this fluid bends the tiny hair cells along the length of the

cochlea, generating signals in the auditory nerve. The nerve signals pass to the brain, which interprets them as sound. Bone conduction hearing is when sound vibrations are transmitted directly from the skull and jaw bones to the cochlea, missing the outer and middle ears. Air conduction sound systems provide stereo quality sound by taking advantage of the ability of the human brain to take in sound from the two ears and integrating the multiple sound sources into a single, richer sound. While bone conduction devices have traditionally been developed for the hearing impaired and as hearing aid devices until recently, these devices focused on transmitting sound in the speaking voice frequency range and have not been adapted for high fidelity musical signals. Additionally, the recreational audio systems for the underwater environment have traditionally relied on air conduction with ear plugs for the sound transmission.

While small, streamline systems exist for land based recreational audio, they are predominately of the air conduction type. Several of these systems have been waterproofed for use by swimmers. These systems rely on ear plugs that are placed in the ear such that an air bubble is formed in the ear canal. When this bubble is intact, the sound transmission is acceptable. However, the ear canal acoustic resonance is lost if it fills with water while the head is submerged. With bone conduction sound transmission, this disadvantage is overcome. Specifically, when the ear canal is filled with water, as when a swimmer is submerged, the mass of the water (4.5 times denser than air) acoustically loads the ear drum enhancing low frequency sound reception in the ear to bone conduction [Tonndorf, J. A New Concept of Bone Conduction, *Arch Otol* 87, 49 - 54 1968].

Common bone conduction type devices have been developed to transmit sound in the speech frequency range and have not been maximized to provide musical sound quality. In addition, bone conduction

devices have been either large units that were heavy, bulky and uncomfortable for the user or have been devices integrated into a bite plate for sound transmission via the jaw bone (May US Patent 5,579,284).Bit plate type of sound transmission actually requires the user to continually bite down on the device in order to hear the sound.

An audio systems using bone conduction is shown in U.S. Patent 4,791,673 to Schreiber. This invention is an audio listening system that includes both a bone conduction device and a sound source unit. The system has a transducer mounted in a c-shaped element that hooks around the ear of the user. A suction cup element is included as part of the transducer feature to ensure contact from the transducer to the mastoid region behind the ear of the user. This device is water resistant but not waterproof and has only one type of transducer to transmit sound to the user.

A further device is shown in U.S. Patent 5,323,468 to Bottesch that provides a means for the conduction of sound waves through the mastoid bones of the user and selectively amplifying predetermined frequency ranges that the invention claims do not conduct well through the bone so as to maximize the transmission of all signals in the sound source frequency range. The invention is a small, light weight head gear that puts one or several transducers in contact with the mastoid region of the skull. The headgear is designed to provide stereophonic music to the user by transmitting the stereo sound signals separately to transducers located behind the ear of the user. This device is not waterproof and only provides one type of transducer for transmitting across the multiple frequency ranges.

A third bone conduction device is shown in U.S. Patent 5,889,730 to May that provides an underwater audio communication system for transmitting voice through bone conduction at the mastoid region of the head. This device is designed to allow voice communication to and from

an underwater user. The device mounts one or more of the same type transducers onto the users scuba face mask. A transceiver and amplifier is located on the back of the users head to transmit and receive ultrasonic sound signals for communication with the user.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a waterproof recreational audio device to allow a listener to hear high fidelity musical signals through transcutaneous bone conduction.

A further object of the invention is to provide high fidelity sound by maximizing the quality of the sound transmission across the three frequency ranges of musical sound.

Another object of the present invention is to provide an integrated recreational audio system that includes both the headphone unit and the signal source unit.

Additionally, an object of the present invention is to enable the user to position the device on the head for tuning of the sound for the user.

The waterproof recreational audio device of the present invention has an enhanced frequency range over that of previous devices so as to overcome the limited sound quality of existing bone conduction systems. In addition, the present invention is integrated into a light weight headgear that is more comfortable than previous hearing aid type units to enable the individual user to adjust the headgear for personal preferences. The waterproof recreational audio device is also constructed to enable high quality musical signals to be 'heard' while in an underwater environment. However, the intended environment should not be construed as limiting the device to this use. Athletic users may appreciate the light weight, waterproof and streamline configuration of the invention while engaging in other athletic activities such as running, biking, hiking, etc.

According to the present invention, the foregoing and other objects are achieved in part by having a transducer in contact with the skull of the user for transmitting musical signals via bone conduction. The musical signals differ from ordinary speech in that the average frequency range for normal speech is approximately 120 Hz to 8,000 Hz, while high fidelity musical signals can range from 20 Hz to over 20, 000 Hz. This range can be extended even further to meet the newer digital sampling technology with high frequencies of almost 40,000 Hz.

The present invention has at least one transducer that is able to transmit transcutaneous sound via bone conduction through the head of the user. The present invention is functional with at least one transducer, however, at least one transducer should also be understood to include a plurality of transducers. An amplifier can also be worn on the head of the user or can be part of a signal source unit to which the transducer or transducers are connected. The present invention is intended to be worn on the head of the user. The transducer may be fixed to a band that encircles the head of the user or other head gear such as hats, helmets, headbands, or eye wear such as goggles, face mask or sun glasses.

The musical frequency range is split into three distinct channels by the present invention. That is: low frequency from 0 Hz to 1000 Hz, mid frequency from 25 Hz to 6,000 Hz and high frequency from 5,000 to over 20,000 Hz. With new digital sampling device, the upper end frequency range can extend to as high about 40,000Hz. The present invention can use commercially available transducers coupled with the amplifier to produce sound in the mid frequency range. The low frequency response is achieved by applying very low frequencies to the head using a vibrotactile transducer. To provide the high frequency musical signal to the user, the present invention can also include an ultrasonic transducer. The ultrasonic transducer may be of a piezoelectric type or similar. Each channel requires special amplification provided by the invention. The low frequency has

low impendence whereas the high frequency device has about 10 times the impedance. Thus, the three channel amplifier is designed to three different impedances. In addition, each of these frequency channels can have their own volume adjustment. The upper end of the volume can be preset to reduce potential damage to the listener. The preset volume can also be limited specifically for the mid frequency range to allow the user to hear external environmental sound and to provide a volume limit such that others in close proximity to the user do not hear the sound signal from the present invention if the device is worn other than underwater.

Perceptually, bone conduction using the three channels of sound, results in a high fidelity sound quality for the purpose of music listening. The three channels, when listened to underwater, permit a flexible sound quality that allows changes in the sound envelope appropriate for musical articulation. The low frequency range channel proposed is conducive to low and high pitch sounds that enhance the appreciation of both human voice and instrumental applications for music. With air conduction minimized by water or earplug, the proposed device also offers unique clarity with minimal distortion. Further, the impediment of air conduction, through water or earplug, with this device also reduces noise that can hamper music appreciation. The sound quality from the three channel device with its three transducers is omnidirectional when heard underwater. With ear masking as described, it has a timbre that is comparable to high fidelity instrumentation with above-surface stereophonic attributes.

The waterproof recreational audio device can also enhance the music signal by enabling tuning of the device to the individual users preference through positioning of the transducers on the users head. The human skull is very asymmetrical with regard to its vibratory response. In addition, there are idiosyncratic vibratory differences due to individual specific skull geometries [Cai, Z., Richards, D. G., Lenhardt, M.L. and

Madsen, A.G., Response of the Human Skull to Bone Conducted Sound in the Audiometric to Ultrasonic Range., *International Tinnitus Journal*, 8, 1, 1 - 8, 2002]. The transducers of the device can be placed in a standard position (i.e., over the ear in the mastoid region and on the forehead in the frontal region, etc.). However, the sound quality may not be considered optimum for some users. To compensate for the acoustics in skull geometry, the transducers can be placed on the head band 180° apart, or at another desired orientation, allowing the user to rotate the band around the head to select the position of best music reception. This can be readjusted underwater due to the different acoustic properties of that medium and its interaction with the head. In a second embodiment, each transducer may be moveable about the head band independently, until the best sound reception is achieved. This allows custom tuning for each frequency band resulting in the greatest user satisfaction.

As a waterproof recreational audio device, the present invention has a further embodiment that integrates the sound source with the sound transmission. This sound source can be in the form of a disk player (e.g., CDs, DVDs, minidiscs, etc.), MP3 player, AM/FM radio, audio transceiver or other such devices known as personal audio devices. The sound source can communicate with the transducers by wireless or wired connection.

Finally, the objects are met by providing the functional elements and a method for positioning the transducers at various locations on the head of the user. The transducers may be fixed to the band or other head gear and the head gear would be rotated around the head. In addition, the transducers may be able to slide to different locations around the head gear. Finally, the transducers may be able to be removed from the head gear and then to be replaced in another location around the head gear. As a minimum, the user should be able to locate transducer at the front and the back of the head. By moving the transducers, the user may improve both perceived personal sound quality and personal comfort for wearing the

device.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, aspects and advantages will be better understood from the following detailed description of a preferred embodiment of the invention with reference to the drawings, in which:

Figure 1 shows a user wearing the waterproof recreational audio device, system as a head band.

Figure 2 shows one or several transducers located within the headband.

Figures 3a shows the means of connecting and moving the transducers relative to the user and the head band by sliding the transducers along a guide on the head band.

Figure 3b show the means of connecting and moving the transducers relative to the user and the head band using hooks or snaps.

Figure 3c show the means of connecting and moving the transducers relative to the user and the head band using Velcro.

Figure 4 shows a simple block diagram for amplifier unit.

Figure 5a shows the components of the high frequency transducer.

Figure 5b shows one embodiment of waterproofing on a cross section of a transducer with the head band.

Figure 6a shows a wired connection to a sound source.

Figure 6b shows a wireless connection to a sound source.

Figure 7 shows a configuration of the device attached to a hat.

Figure 8 shows a configuration of the device attached to a helmet.

Figure 9 shows a configuration of the device attached to swim goggles.

Figure 10 shows another embodiment with a transducer located on the frontal region of the head and a stabilizing strap across the top of the

user's head.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

Referring now to the drawings, and more particularly to Figure 1, the preferred embodiment of the waterproof recreational audio device is as a comfortable, light weight head band 1 worn by a user. The head band 1 in Fig. 1 can be worn with eye wear such as swimming goggles. The transducer 2 is located on the inside of the head band 1 to allow contact with the head of the user as shown in Figure 2. Sealed, waterproof wiring (not shown) would be located inside the head band for connecting to a signal source.

One of the major advantages of the waterproof, recreational audio device is the tuning capability. The skull has many vibratory modes which are likely to be specific to an individual. The unique vibratory pattern of a head is a product of the skull and brain complex geometry, mass and other acoustic properties. The listener compensates for poorly propagating areas of the skull by moving the transducer 2 around the head until optimal sound quality is obtained. Placement at different locations (frontal, temporal parietal occipital etc.) may dramatically improve listening quality since the head is part of the propagating medium for bone conducted sound on the way to the inner ear.

A preferred configuration is to have two or more transducers 2 located at different positions around the head band 1 (e.g., 180° apart). The user could then tune the sound by rotating the head band 1 around the head. Another means for tuning the sound would be to locate the transducers 2 by sliding them around the head band 1on a slide positioning guide 3 shown in Figure 3a. Figure 3b shows the use of hooks/snap positioning means 4 connections that would be used to locate the

transducers 2 at several positions around the head band 1. Figure 3c shows hook and loop material (e.g., Velcro ®) inside the head band 1 as the means to allow the user to remove and replace the transducers 2 in preferred positions around the head band 1 for tuning.

In order to maximize the sound quality of the musical signal, the sound source is amplified and split into three frequency channels. The amplifier unit shown in Figure 4 is powered by a battery 17. A source signal 18 is received from the sound source and presented to the pre-amps 22 on the driver board 19. The signal source is split into the three frequency channels by the band pass filters 24.

Amplifiers 23 further enhance the low frequency channel, mid frequency channel, and high frequency channel signals. There are three attenuators 21, each controls the volume in each of the frequency channels. The listener increases the volume until comfortable in each channel. In this way compensation for the individual differences in sensitivity or preference is obtained. The mid frequency attenuator is preferably set with a maximum level of 90dBa for 8 hours to limit the volume of the mid range such that individuals near the listener should not be able to hear the sound.

The three channel signal drivers 20 couple the signal to the appropriate transducer 2. The low frequency transducer 2 can be an Audiological Engineering Inc. device or similar device. The mid frequency transducer 2 can be a Radioear Corporation device or similar device, and the high frequency transducer 2 can be a custom designed device from Blatek Inc. further described in Figure 5a, or a similar device. The high frequency sound signal 25, mid frequency sound signal 26 and low frequency sound signal 27 are heard by the user through contact with the transducers 2 to the head of the listener.

The high frequency transducer shown in Figure 5a may be constructed to include of a 1.215 inches dia. X .032 inches thick aluminum

disk 12. The aluminum disk 12 is located on top of the .05 inches dia. X .020 inches thick Lead Zirconate Titanate (PZT) disk 13. The PZT (ultrasonic) disk 13 sits within an Aluminum collar 14 that has an outer diameter of 1.25 inches with a wall thickness of .052 mm. The size of the components can vary, which will alter the vibratory response. This may be valuable in some applications. The aluminum collar 14 has a recess machined such that the aluminum disk 12 fits flush along the top of the aluminum collar 14, and the PZT disk 13 vibrates within the cavity created by the aluminum collar 14 and the aluminum disk 12. The signal source is received by the transducer via the wire connected to the insulated solder pin 15 and is grounded by the case ground solder pin 16. The insulation pin can be replaced on one side allowing the connector wire to cross the interior of the transducer.

The intended embodiment of the waterproof recreational audio device/system is to be able to operate in underwater and other high humidity environments. Examples of sub-aquatic, underwater environments include, but are not limited to, recreational and competitive swimming. However, it also includes, but is not limited to, scuba diving or other deeper water environments. Examples of above-water, high humidity environments include, but are not limited to, jogging, bicycling, hiking or other recreational activities that might expose the device and ear canal to excessive moisture, such as with rain, thereby interfering with normal air-conducted sound.

As such, in most applications of the invention, the transducers should be waterproof. Figure 5b shows a cross section of the transducer 2 connected to the head band 1. The transducer 2 preferably is waterproofed by rubberized or polymer coating 6. Water proofing is a accomplished by silicone sealing or silicone gaskets may also be used. The main function of the waterproofing is to protect the transducers from a water or humid environment (e.g., rain), while at the same time allowing the transducers to

transmit, via bone conduction, the musical signal to the wearer. As such, any waterproofing that accomplishes this objective might be used in the practice of this invention.

Another embodiment of waterproof recreational audio device is to include the sound source as part of the system. The sound source can be an MP3 player, CD player, or other portable musical device. The sound source 7 can be worn on the arm of the listener as shown in Figure 6a and 6b. The sound source is coupled to the head band 1 by a wired connection 8 shown in Figure 6a or by a wireless connection as shown in Figure 6b. The wireless connection would comprise a sound source wireless means 9a that would communicate with the head band wireless means 9b by transmitting and receiving the sound signals as radio, supersonic, or similar transmission means.

Although the preferred embodiment is a head band 1, the listener may want to use other types of head gear to position the transducers 2 in contact with the head. Figure 7 shows the transducers 2 are preferably located within a hat 28 that would be worn by the user. The transducers 2 are located inside the hat, next to the head of the listener. Other embodiments would be to locate the transducers 2 inside a helmet 29, such as a bike helmet 29 shown in Figure 8 or to locate the transducers 2 on the band of eye wear such as the goggles 30 shown in Figure 9.

Comfort of the user and tuning of the signal are major features for the waterproof recreational audio device. In the event a user wants to position at least one of the transducers 2 on the frontal region of the head, a stabilizing strap 11 is available to hold the head band 1 more securely when a transducer 2 is fixed to the frontal position as shown in Figure 10. The amplification at the three different frequency bands can be independently adjusted providing a personalized audio experience of high fidelity. Unlike air conduction, in which the pathway is the same for all frequencies, the skull unique geometry for each individual requires the

device to be tune for maximum satisfaction. Tuning the frequency bands is accomplished by manipulating three attenuators, each of which controls the volume in each of the frequency channels. The listener increases the volume until comfortable in each channel. When all are at a comfortable listening level the user can fine tune the response of all three channels in air and again underwater. In this way compensation for individual differences in sensitivity or preference is obtained. If the listeners wishes the audio image to appear in the center of the head, careful adjustment of the volume is necessary in all three channels

Tuning the volume of the three channels still may not result in the optimal high fidelity experience of sound in the head. Tuning the transducers to the head by positioning may be required. The skull has many vibratory modes which are likely to be specific to an individual. The unique vibratory pattern of a head is a product of the skull and brain complex geometry, mass and other acoustic properties. The listener compensates for poorly propagating areas of the skull by moving the tranducers around the head until optimal sound quality is obtained. Placement at different locations (frontal, temporal, parietal, occipital, etc.) will dramatically improve listening quality since the head is part of the propagating medium for bone conducted sound on the way to the inner ear. Transducer adjustment underwater may also be necessary given that medium's difference in acoustical properties from air.

The fidelity of the sound underwater with the device may be enhanced by ear plugging through a masking phenomenon that reduces sound interference of impeded air-conducted sound. This ear plugging can be accomplished with commercially available ear plugs (e.g., silicon); or, at a suitable water depth, there will be normal water loading of the external auditory canal. However, the latter method may not be reliable with recreational or competitive swimming, and ear plugging may be desired. The user may elect, however, not to use ear plugs, and a quality fidelity

sound will still be accomplished with the device. Placing plugs in the ear canal changes the quality of sound by bone conduction. This is termed the occlusion effect (Tonndorf, J. A new concept of bone conduction, *Arch Otol* 87, 49-54, 1968) and it enhances bone conduction listening by increasing the perception of lower frequency sound. The use of plugs or not is the listeners choice. Plugs will require intensity adjustment and possibly transducer placement on the head to create the optimal audio experience.

While the invention has been described in terms of a single preferred embodiment, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the appended claims.

CLAIMS

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is as follows:

1. A waterproof recreational audio device for providing musical signals to a user, comprising:

at least one transducer, such that said transducer enables music to be heard by said user via transcutaneous bone conduction;

a means for said at least one transducer to be in vibratory contact with the head of said user; and

means for waterproofing said at least one transducer.

2. The waterproof recreational audio device according to claim 1, wherein said at least one transducer includes a plurality of transducers.

3. The waterproof recreational audio device according to claim 2, wherein said plurality of transducers is arranged in an array.

4. The waterproof recreational audio device according to claim 2, wherein the musical frequency range is split into three frequency channels.

5. The waterproof recreational audio device according to claim 4, wherein said three frequency channels consist of:

a low frequency range,

a mid frequency range, and

a high frequency range.

6. The waterproof recreational audio device according to claim 3, wherein at least one of said transducers in said array is an ultrasonic transducer.

7. The waterproof recreational audio device according to claim 3, wherein at least one of said transducers in said array is a vibrotactile transducer.

8. The waterproof recreational audio device of claim 1, wherein said audio device includes at least one amplifier.

9. The waterproof recreational audio device according to claim 1, wherein at least one of said transducers is positionable at the front of the head of said user.

10. The waterproof recreational audio device according to claim 1, wherein at least one of said transducers in said array is positionable at the back of the head of said user.

11. The waterproof recreational audio device according to claim 1, wherein said transducer is associated with a band that encircles the head of a user.

12. The waterproof recreational audio device according to claim 1, wherein said transducer is associated with a hat that is worn on the head of said user.

13. The waterproof recreational audio device according to claim 1, wherein said transducer is associated with a helmet that is worn on the head of said user.

14. The waterproof recreational audio device according to claim 1, wherein said transducer is associated with a band of recreational eye wear selected from the group consisting of swim goggles, ski goggles, snorkel mask, and sun glasses.

15. The waterproof recreational audio device according to claim 5, wherein said low frequency range volume is adjustable.

16. The waterproof recreational audio device according to claim 5, wherein said mid frequency range volume is adjustable.

17. The waterproof recreational audio device according to claim 5, wherein said high frequency range volume is adjustable

18. The waterproof recreational audio device according to claim 1, wherein said mid frequency range has a fixed maximum signal level of 90 dBa for 8 hours.

19. The waterproof recreational audio device of claim 1, wherein said waterproof recreational audio device transmits a musical signal of a high fidelity frequency response across a broad frequency range where there is:

a low frequency response is in the range of 40 - 1000 Hz

a mid frequency response is in the range of 250 - 6000 Hz, and

a high frequency response is in the range of 5000 - 20,000 Hz.

20. The waterproof recreational audio device of claim 19, wherein said at least one transducer includes an ultrasonic transducer.

21. The waterproof recreational audio device of claim 19, wherein said at least one transducer includes a vibrotactile transducer.

22. The waterproof recreational audio device of claim 19, wherein said waterproof recreational audio device includes an adjusting capability for the mid range frequency response, such that:

said mid frequency range volume can be adjusted to allow environmental noise to be heard by the user,

said mid frequency range has a fixed maximum level to minimize nuisance noise for individuals near said waterproof recreational audio device, and

said mid range has a fixed maximum level to restrict harmful dB noise levels for user.

23. The waterproof recreational audio device of claim 19, wherein a volume of said low frequency range is adjustable.

24. The waterproof recreational audio device of claim 19, wherein a volume of said mid frequency range is adjustable.

25. The waterproof recreational audio device of claim 19, wherein a volume of said high frequency range is adjustable.

26. The waterproof recreational audio device of claim 19, wherein said mid frequency range has a fixed maximum signal level of 90 dBa for 8 hours.

27. The waterproof recreational audio device of claim 1 further comprising a sound source in communication with said at least one

transducer, said sound source generating a music signal which is received by said at least one transducer.

28. The waterproof recreation audio device of claim 27 wherein said communication between said sound source and said at least one transducer is via a wired connection.

29. The waterproof recreation audio device of claim 27 wherein said communication between said sound source and said at least one transducer is via a wireless connection.

30. The waterproof recreation audio device of claim 27 wherein said sound source is affixed to said means for said at least one transducer to be in contact with the head of said user.

31. The waterproof recreation audio device of claim 27 wherein said sound source is selected from the group consisting of MP3 player, tape player, radio, audio transceiver, and disc player.

32. A recreational audio device, comprising:

at least one transducer which enables music to be heard by a user via transcutaneous bone conduction; and

a support which supports said at least one transducer in contact with a head of a user at a plurality of locations around the head of said user.

33. The recreational audio device according to claim 32 wherein said at least one transducer includes a plurality of transducers.

34. The recreational audio device according to claim 32 wherein said at least one transducer can be removed from said support and re-positioned at at least one different location on said support.

35. The recreational audio device according to claim 32 wherein said at least one transducer can slide to different locations on said support.

36. The recreational audio device according to claim 32 wherein said support can be oriented at multiple orientations relative to a head of a user.

37. The recreational audio device of claim 36 wherein said support is a head band.

38. The recreational audio device of claim 32 further comprising waterproofing for said at least one transducer.

39. The recreational audio device of claim 32 further comprising a sound source for conveying musical signals to said at least one transducer.

40. A method for a user to listen to music via transcutaneous bone conduction, comprising the steps of:

supplying musical signals from a source to at least one transducer capable of transcutaneous bone conduction;

contacting a user's head with said at least one transducer; and

transmitting by transcutaneous bone conduction said musical signal to the user.

41. The method recited in claim 40, further comprising a step of tuning musical sound heard by a user.

42. The method of claim 41 wherein said step of tuning comprises changing point of contact of at least one transducer on a user's head.

43. The method of claim 42 wherein changing is accomplished by repositioning a support which supports said at least one transducer on said user's head.

44. The method of claim 42 wherein changing is accomplished by repositioning said at least one transducer on a support which supports said at least one transducer.

45. The method of claim 42 wherein changing is accomplished by sliding said at least one transducer to a different location on a support which supports said at least one transducer.

46. The method of claim 40 comprising adjusting volume of at least one a high, mid, or low frequency transmitted via transcutaneous bone conduction via said at least one transducer.

47. The method of claim 40 further comprising limiting a mid frequency range has a fixed maximum signal level of 90 dBa for 8 hours.

Figure 1

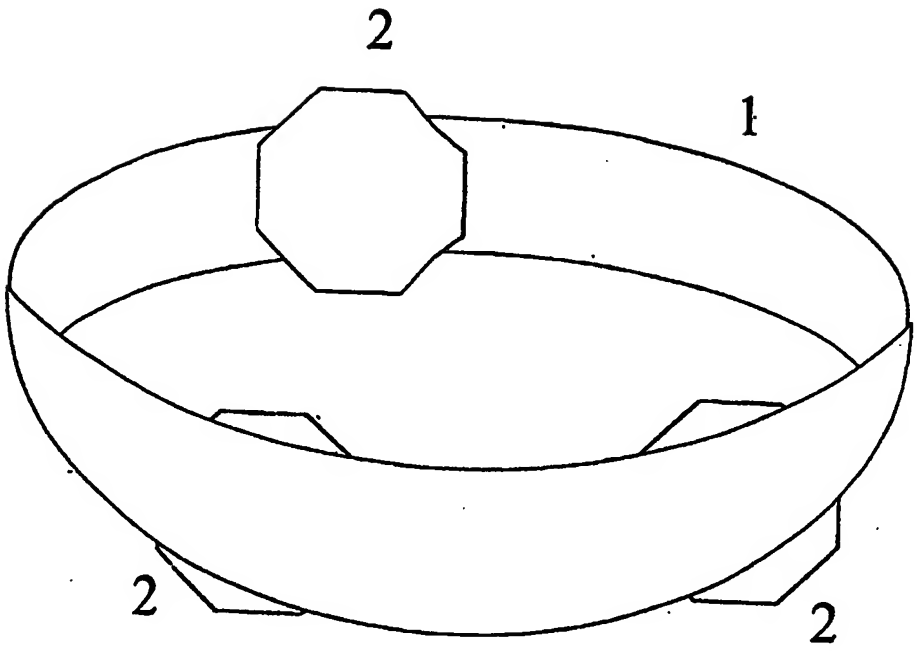


Figure 2

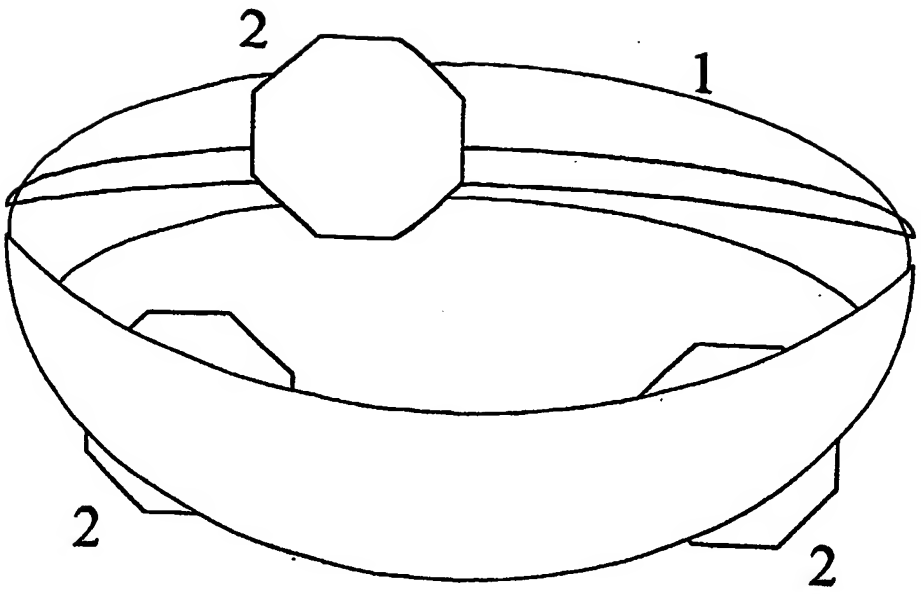


Figure 3a

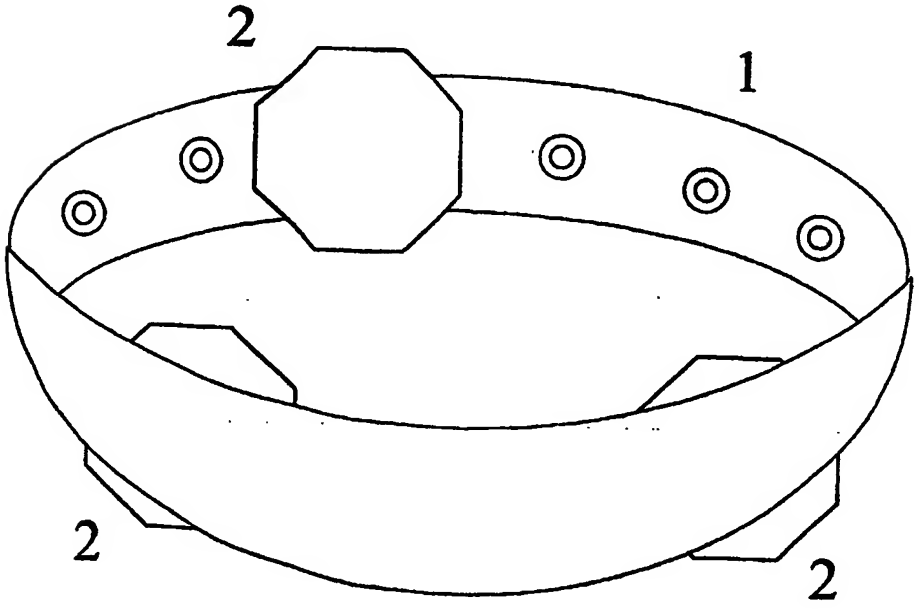


Figure 3b

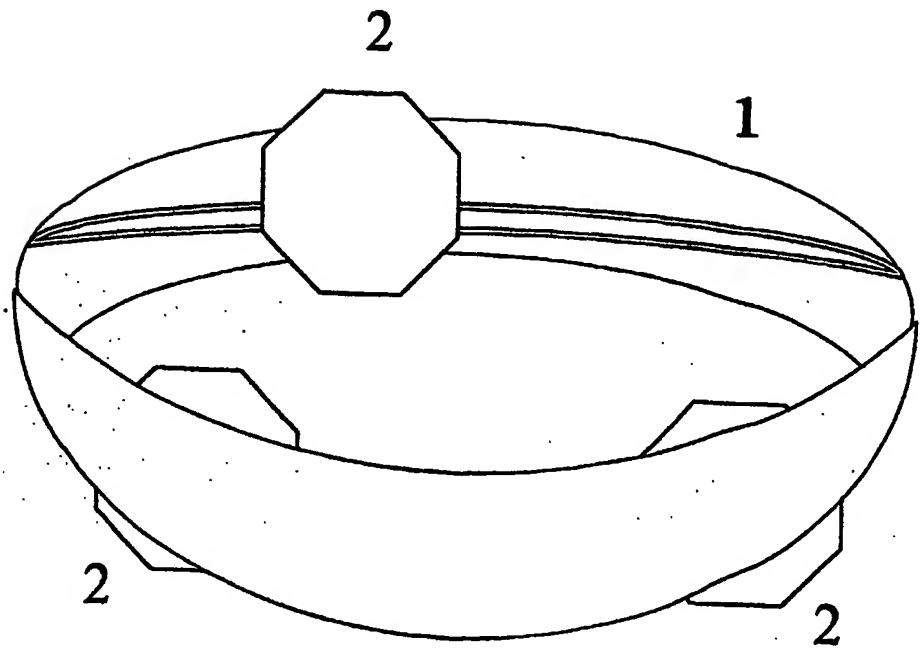


Figure 3c

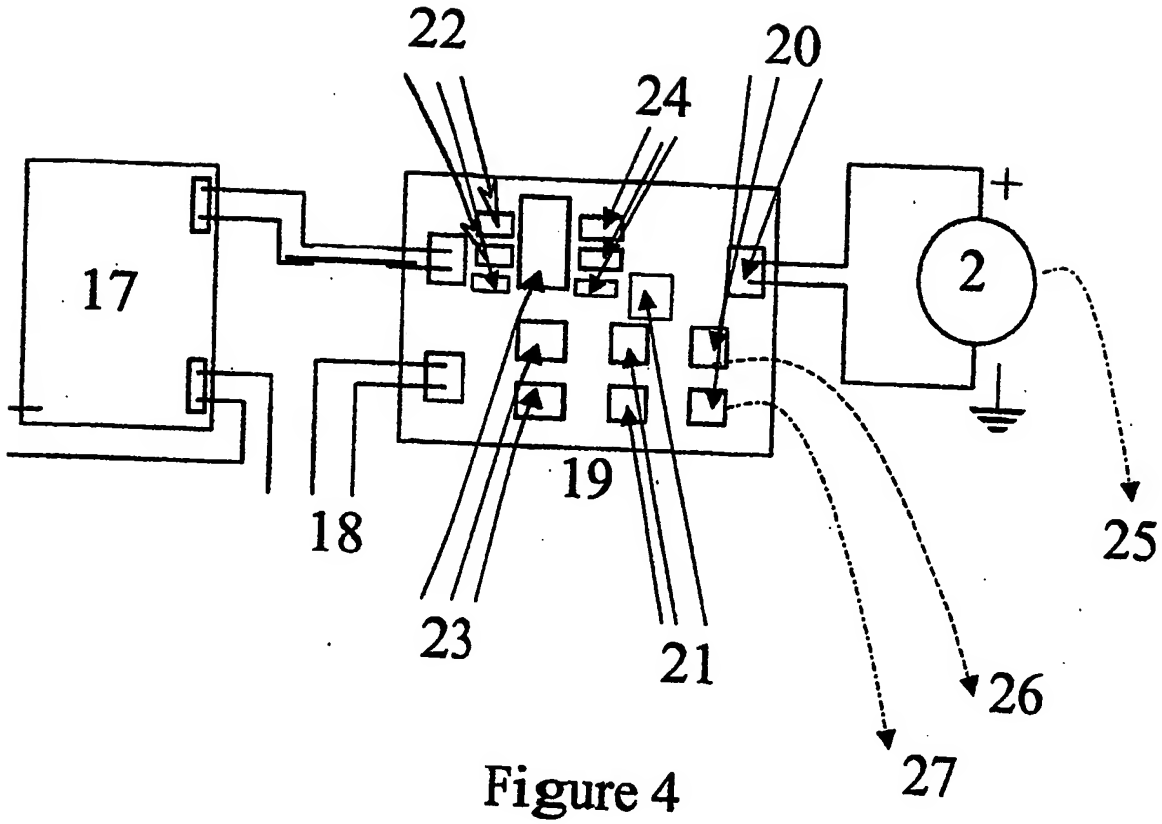


Figure 4

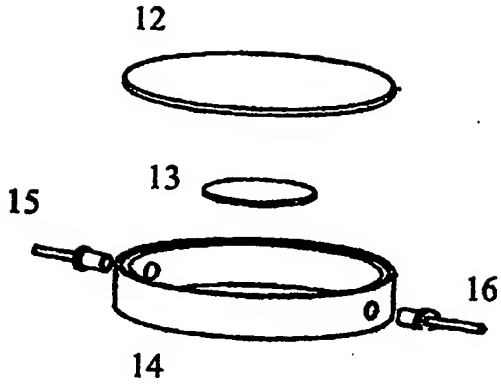


Figure 5a

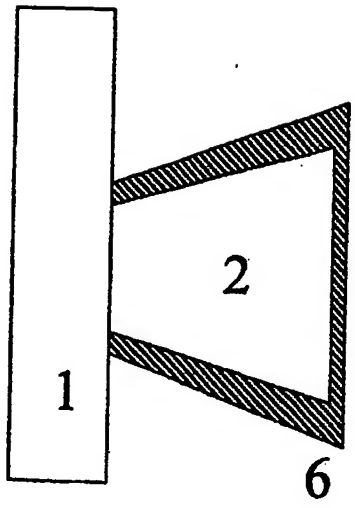


Figure 5b

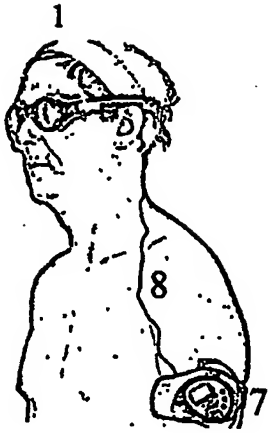


Figure 6a

Figure 6b

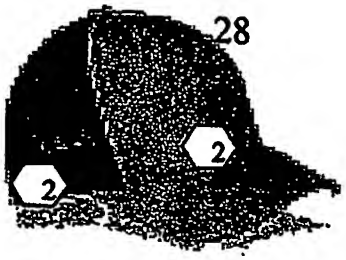


Figure 7

13

Figure 8

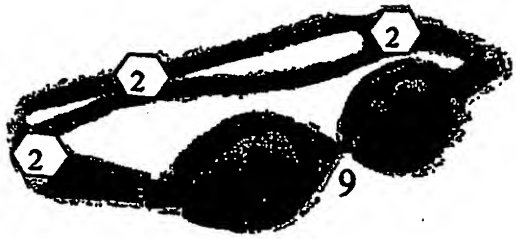


Figure 9

Figure 10

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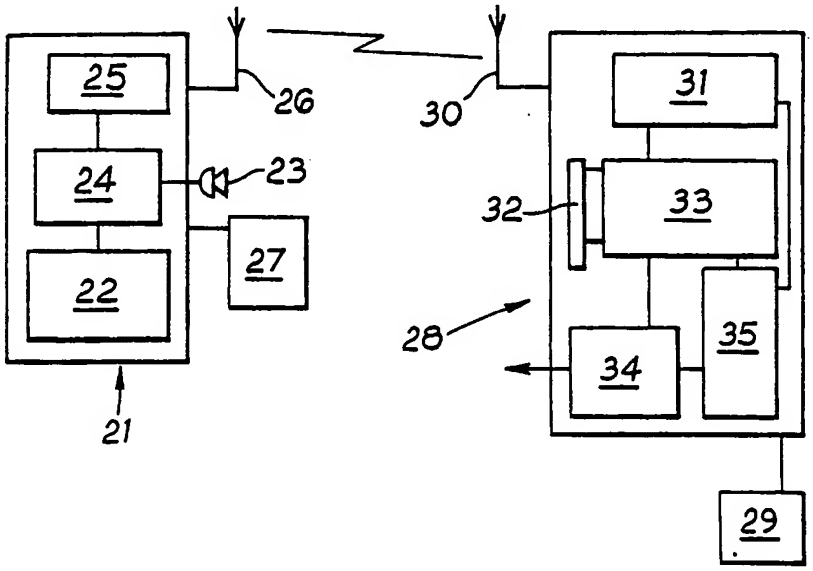

(57) Abstract

A communication system especially for coaching swimmers comprises a hand set which the coach uses to summon up a swimmer or swimmers to be instructed by means of generated tones and a thing worn by each swimmer to be instructed which contains electronic amplifying means and audio transducers. To water proof the electronics they are enclosed in a sealed enclosure and then in the latex of a swimming cap. Batteries used in the circuitry can be recharged without breaking the sealing by using a strong magnetic field to break through the water-proofing and drive a constant current battery charging arrangement.

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COMMUNICATION SYSTEM

FIELD OF THE INVENTION

The present invention relates to communication systems.

BACKGROUND OF THE INVENTION

The invention arose from a problem in coaching swimmers. A swimming coach watches his swimmers from a pool surround and yells his instructions. Swimming pools especially when indoors are noisy places and it is difficult for any swimmer to understand the shouted instructions. Normally there are many swimmers being coached at the same time and thus each swimmer has to listen for any instruction which might be meant for him and ignore instructions meant for any one else; this is distracting to the swimmer.

The invention is not however limited to swimming instruction but is applicable to most sports and other communication.

The present invention aims to provide a communication system for the transmission of instructions from an instructor to a class or other group of instructees.

SUMMARY OF THE PRESENT INVENTION

One aspect of the present invention provides a communication system comprising an instruction unit linked electro-magnetically to a receiving unit in something to be worn by an instructee.

The electro-magnetic linking can be done at audio frequency by having a loop surrounding the class or group or by radio transmission. If radio transmission is used, the transmitter should be of low power say 1 watt of radiated power to avoid too large an area in which the signal can be received.

The system can incorporate an encryption or scrambling device to prevent outsiders eavesdropping on the instructions given. There is keen rivalry between swimming coaches.

The system can also incorporate a switching arrangement whereby an individual and/or a sub-group and/or the entire group can be addressed so the instructor can give instructions to whichever individual he selects,

to whichever of a number of pre-selected sub-groups he choses and/or the entire group. It would of course be possible to arrange for a plurality of individuals to be instructed without the need for determining in advance which sub-group they belonged to.

The receiving unit has to include an audio-transducer to produce the sound. This audio-transducer can be in the form of ear-piece to be received in the instructee's ear; this has an advantage in that the power demanded from the unit is low but it is difficult to render such a transducer water-proof in a swimming environment. It is preferred in a swimming environment to use a transducer which is enclosed in a water-tight case and then to incorporate that case in the latex of a swimming cap, which in the case of a swimmer or diver would be the said something worn. In a non-watery environment, the said something could be in the form of a head-piece with ear-pieces to fit in the ears although there is nothing to prevent said something being anything worn or carried by the instructee.

Instead of instructions going direct from the instruction unit which can be a hand-held unit, it would be possible to use a relay unit to augment the signal and the relay unit can derive power from a mains supply.

In another aspect of the invention, a swimming cap has provision for receiving an electronic signal receiving unit.

Said provision can be in the form of ~~a pocket~~ or pockets into which the unit can be inserted.

A further aspect of the invention provides a swimming cap incorporating an electronic signal receiving device.

The cap can incorporate the said receiving unit by being made in a dipping process with the unit being between two skins or by having a patch vulcanised over the unit.

The receiving unit can be made in two parts each fitting over an ear with each part containing an audio-transducer with one in addition having the electronic

circuitry and the other a power supply.

Unfortunately it has been found that the power demand of the receiving unit and particularly that of the transducers gives an undesirably short life of the receiving unit when non-rechargeable batteries are used. It has therefore been found desirable to use rechargeable batteries. It has also been found desirable to switch off the unit when not in use. To avoid the need for mechanical switches, the unit can be switched on by an electronic signal and be held on for a determined period. One way of doing this would be for a part of the circuit to sense when a signal was being received and to switch off the remainder of the circuit if the signal was not addressed to it and another would be to switch the circuit on when a signal was applied and then switch it off only after a delay.

A yet further aspect of the invention provides a method of recharging batteries without direct contact by placing the batteries with a charging circuit in an alternating magnetic field with the circuit rectifying an alternating voltage derived from the field and deriving a constant current to recharge the batteries.

It has surprisingly been found that water does not attenuate the radio frequencies used in a prototype sufficiently to prevent the prototype being used in swimming coaching, indeed the prototype was effective in six foot of water that is with a trainee at the bottom of the deep end of a swimming pool which was nominally six foot deep (six foot is over 1.8 metres).

The invention will now be described, by way of example, with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram of a communication system according to the present invention for use in coaching swimmers,

Figure 2 illustrates a variant,

Figure 3 is a perspective view of an instruction unit,

Figure 4 is a circuit diagram of the instruction unit,

Figure 5 is a circuit diagram of a receiving unit

Figure 6 shows the arrangement of cells forming a battery used in the circuit of Figure 5,

Figure 7 is a view of a swimmer wearing a cap embodying the present invention,

Figure 8 is a section of a detail on line VIII-VIII of Figure 7,

Figure 9 is a schematic section showing detail of Figure 8,

Figure 10 is a a view of how the receiving unit can be worn for other uses,

Figure 11 shows diagrammatically a recharging unit for the battery used in Figure 5, and

Figure 12 illustrates how the unit of Figure 11 co-operates with circuitry connected to the battery to charge the battery.

DESCRIPTION OF EXEMPLARY EMODIMENTS

Figure 1 shows in block outline a communication system. A hand-held instruction unit 21 incorporates a key board and associated logic circuitry 22 which will be mentioned in more detail in relation to Figure 3, a built-in micro-phone 23, a speech encoding circuit 24, amplifying circuitry 25, and an aerial 26 all powered by a battery 27 or mains electricity, a rechargeable battery is preferred. A receiving unit 28 comprises a battery 29, an antenna 30, radio-frequency amplifying stages 31 possibly in the form of a heterodyne receiver, means 32 for detecting whether the received signal contains a component identifying that the signal is intended for that receiving unit, a decoding arrangement 33, an audio-stage amplifier 34 and a power supply logic circuit 35. The transmission frequency can be of the order of 27 MHz or 49 MHZ but is not critical and the radiated signal has a low power of say 1 watt and is preferably frequency modulated. Depending on the supplier of the transmitters and receiving units, there can be any reasonable number of receiving units associated with one instruction unit. These receiving units would be indentical one with another except for unit-identifying tracks (not shown) which would be processed during manufacture to give a unique identifying code and codes common to a group and to a sub-group, it is theoretically possible to have the said common codes as part of the unique codes (so the unique codes would be ABA,ABB, ABC etc. with the group code A and the subgroup code AB with the receiver sensing the final letter and cutting off the receiver if the final letter is not the right one) and this would economise on tracks.

Figure 2 illustrates a variant wherein instead of restricting the range by using low power to avoid polluting the magnetic spectrum away from the instruction area, the instruction area 36 is surrounded by an induction loop 37 driven by a relay unit 38 which is mains powered 39 and can receive a signal from the instruction unit 21 by extremely low-power radio

transmission or by a cable link 40.

Figures 3 and 4 illustrate an instruction unit. This instruction unit is contained in a water-tight plastics material case 41 the back of which is adapted to receive notes written on it with say a grease pencil or other marker. The circuit inside the case as shown in Figure 4 comprises a stop watch chip 42 controlled by an initiating button 43 (Figure 3) and a stop button 44 (Figure 3), a display 45 for the stop watch, a microphone 46, and audio amplifier chip 47, a battery 48, an on-off switch 49, a calling tone generator chip 50, an array of addressing buttons some 51 of which are intended to summon an individual and others 52 a group of individuals, these buttons controlling the tone generated, a chip 52' for superimposing the output of the tone generator chip on the output of the audio amplifier, and a radio frequency amplifier chip 53 with its frequency deciding oscillator 54. The precise circuitry and components have not yet been finalised and so it would be misleading to give components and precise circuitry. However the requirements for the stop watch chip are that preferably it is of a type that not only has an initiating and a stop button but also has an arming button 55 permitting the timing to start on a receipt of a large signal on line 56 from the microphone denoting arrival of a loud noise such as a start-race signal. The calling tone generator can be in the form of a micro-processor which could not only synthesise the tones but perhaps could without too much cost allow the buttons 52 to cover variable groups of individuals by a programme which included a step that pushing a button 52 followed shortly by pushing buttons 51 meant that that button 52 thereafter meant the pushed buttons 51 and then cycle the tones between the codes for the right buttons 51; the receiver unit presently developed relies on each button 51 or 52 having a distinct tone and so is tuned to two tones or more. The output of the chip 53 is fed through a rubber covered aerial 26.

Figure 5 is a circuit diagram of a receiving unit. Whilst development is not complete and no provision has been made for scrambling the signals as indeed was the case in Figure 4, development has proceeded far enough to give fuller details. The antenna 30 which can be in the form of a pick-up loop passes the incoming signal through a filter 60 such as a Ceramic Murata SFE49 to a radio-frequency amplifying chip 61 such as a Mullard TDA T021 with a beat oscillator 62 controlled by a 49.80 Megahertz crystal oscillator 63. The output of the chip 61 is fed to a tone sensing chip 64 such as a CML FX335SLVI through a noise eliminating filter 65. With the chip 64 there are associated a frequency-standard oscillator 66 such as a 1 MegaHertz crystal and a succession of breakable links 67 to determine the tones to be sensed. The output of the chip 64 which is the output of the chip 61 only when the correct tone is sensed is fed through amplifier stages 68 to an audio transducer arrangement 69. Another output from the chip 64 is taken to a power switching chip(such as a 74HC02)69 which receives a voltage from a battery 70 and switches that voltage off or on ('on' means to the rest of the circuitry direct or through a voltage regulator 71). This chip is switched into one state by a signal from the chip 64 or a large signal taken from the antenna 30 on line 72 and this state is the one passing the voltage. This chip 69 is held in that state until the state is reversed by another chip 73 such as a 74HC4060 which is a counter timer setting a delay of say 30 minutes. The signal on the line 72 will only be large if the antenna is very close to the transmitter and so this is used to set the receiver unit functioning at the start of a training session and thereafter this signal will be weak and only the signal from the chip 64 (which has been switched on) will operate the chip 69.

Figure 6 shows an arrangement of cells 80 forming the battery 70 of Figure 5. Seven miniature nickel-cadmium cells packed six around a central one with suitable connections to arrange them in series can provide 8.40 volts with a capacity of 60 milliampere-hours within a diameter of 5 cm. and a depth of 6 mm. even when the cells are encapsulated in a water-proofing plastics material.

Figures 7 to 9 illustrate the mechanical arrangement of the receiving unit. Figure 7 shows a swimmer wearing a bathing cap 82 which has a projection 83 over each ear. Figure 8 shows that each projection contains a part 84 embodied in the cap as by the parts with a stretchable electric interconnection 87 being attached to a layer 85 formed by a first moulding dip with a second layer 86 being formed over the first layer and the parts and interconnection by a second moulding dip. Each of the parts 84 contains an audio transducer 88 such as of Murata piezoelectric material and forming part of the arrangement 69 with each part being contained in a sealed enclosure 89. The walls of the enclosure are spaced from the transducer on all sides and there is free space behind the transducer to receive in one part the battery 70 and in the other part a printed circuit board 90 mounting the circuitry of Figure 5 which board is about the same size as the battery (this is facilitated by using surface mounted components), and the antenna 30.

Figure 10 illustrates that the receiving unit can be mounted otherwise than in a swimming cap for other uses. Figure 10 actually shows the receiving unit in a sweat band for foot sports with the receiving unit being in one or two parts. It is not essential to use rechargeable batteries in uses where water-proofing is not a key issue. In uses demanding head protection, the receiving unit can be incorporated in a helmet.

Figures 11 and 12 illustrate a way of recharging the battery 70 without removing, or obtaining direct contact with, it so it can remain sealed within the enclosures for the life of a swimming cap. The caps

of several swimmers can be thrown into a non-metallic container 91 surrounded by a coil 92 in series with a capacitor 93, the coil and the capacitor being resonant at a frequency of say 25 kiloHertz. An oscillator 94 resonating at this frequency such as a Levell TH150 DM feeds a power amplifier 95 such as a GA28F Mosfet powered by a power supply unit 96 such as a Farnell LT30.2 which in turn keeps the coil 92 strongly resonating. The resulting magnetic field is picked up by a coil 97 in Figure 12 which can be the aerial or antenna 30. This coil is then connected to a current regulating device 98 consisting of a reference Zener diode 99, resistors 100 and a transistor 101 to charge the battery at a constant low current. The orientation of the coil 97 does not seem critical within a wide range of orientations.

No provision has been made in the described embodiments for avoiding eaves-dropping but this would seem to be a mere matter of incorporating commercially available scrambling chips in the circuits.

The radio-frequency used depends largely on the licensing authorities allocating frequencies and their restrictions on power outputs at permissible frequencies. Thus in the U.K., theauthorities will only permit minimal power at 49 MHz and so 27 MHz when they will permit.4 watts will be better.

It is possible to use independent receiving units for each ear when it is desired to use two earpieces with each unit being self-contained with its own battery and circuitry. This avoids the need for a stretchable electrical connection which even with connection anchorages may be a source of failure if the wearer uses the projections 83 as an aid in pulling a swimming cap on. It is not thought that the connection would be a source of weakness and it would only be necessary in any event to wind the connection around the enclosure to give a firm anchorage taking any strain off the connection's terminations.

C L A I M S

1. A communication system comprising an instruction unit linked electromagnetically to a receiving unit in something to be worn by an instructee.

2. A system according to claim 1 wherein the instruction unit drives a loop laid down around an area containing the instructee.

3. A system according to claim 1 wherein the electromagnetic lining is at radio frequency.

4. A system according to any one of the preceding claims wherein the instruction unit comprises a micro-phone and amplifying means and a means for applying an addressing code to the amplifying means output whereby a receiving unit can accept only a signal intended for it.

5. A system according to any one of the preceding claims wherein the said something is a bathing cap.

6. A bathing cap having provision for receiving an electronic signal receiving unit.

7. A cap according to claim 6 wherein said provision is in the form of at least one pocket into which the unit can be inserted.

8. A bathing cap incorporating an electromagnetic signal receiving unit.

9. A cap according to claim 8 wherein the unit is encased within the material of the cap.

10. A cap according to claim 9 wherein the unit is split into two parts joined by wiring with one part being positioned over each ear.

11. A cap according to claim 10 wherein each part contains an audio transducer with one also containing a battery and the other electronic circuitry, each part being contained in a water-tight enclosure with the transducer being spaced from that enclosure.

12. A cap according to claim 11 wherein the battery is of the rechargeable type.

13. A battery recharging arrangement comprising a a non-conductive non-magnetic container into which things can be put, a coil producing a magnetic field

in the container, energising means for the coil, and in the thing a means for deriving energy from the magnetic field and rectifying it.

14. An arrangement according to claim 13 wherein the coil is arranged to be resonant at the energising frequency.

15. An arrangement according to claim 13 or claim 14 wherein the energy deriving means is arranged to yield a constant charging current to the battery.

16. A system substantially as herein described with reference to the drawings.

17. A bathing cap substantially as herein described with reference to Figures 7 to 9 of the accompanying drawings.

18. An arrangement for recharging batteries substantially as herein described with reference to Figures 10 and 11 of the accompanying drawings.

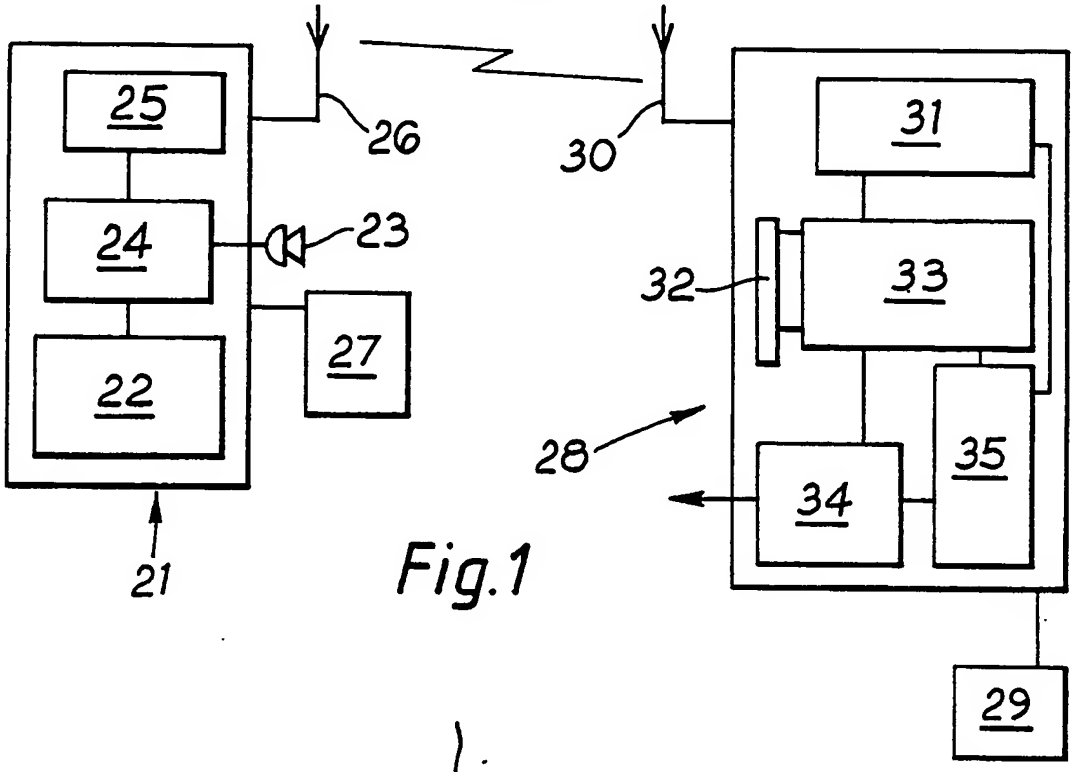


Fig.1

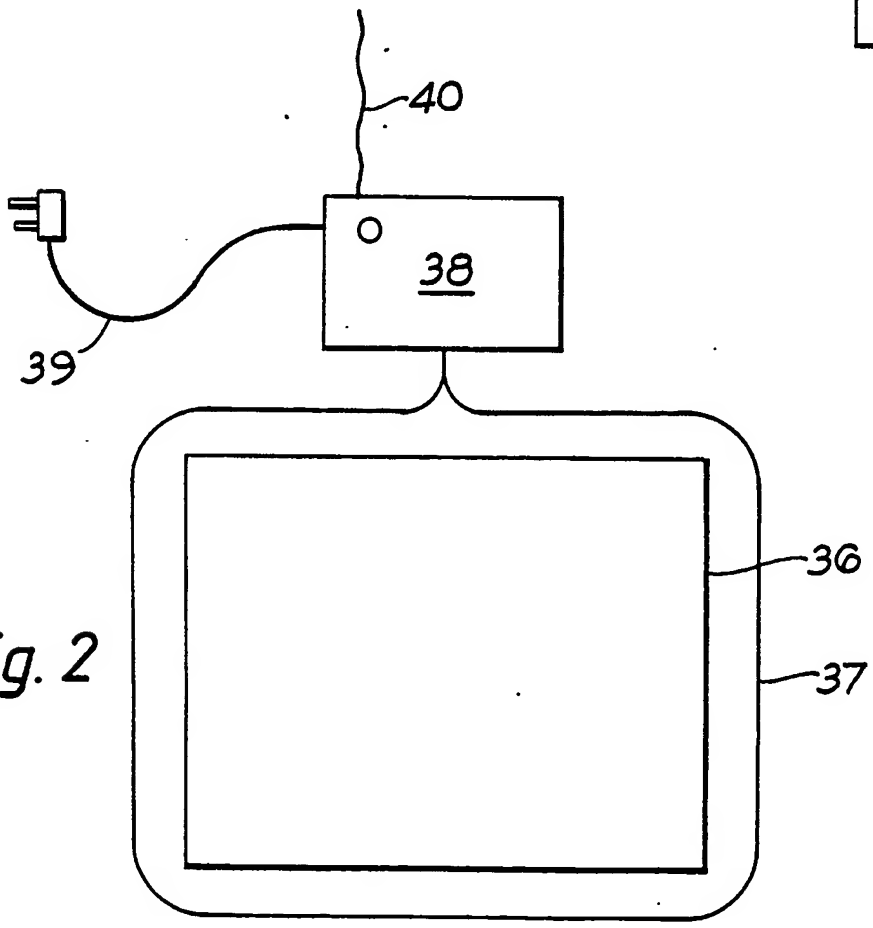
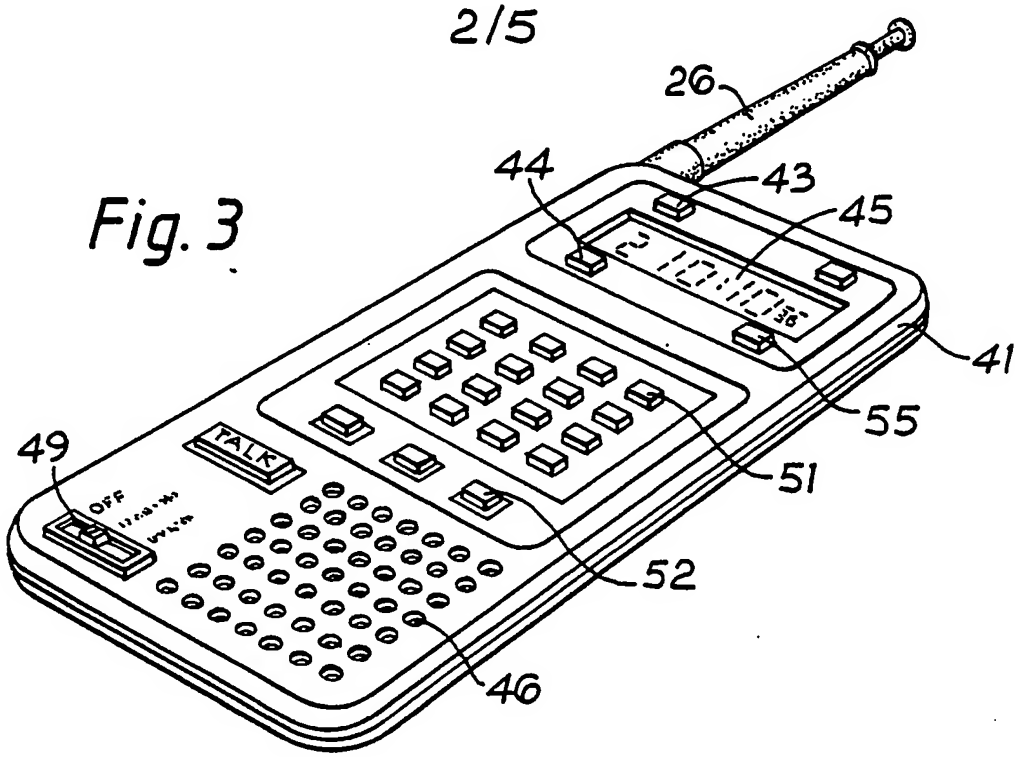


Fig. 2

Fig. 3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44
43
45
41
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51
49
TALK
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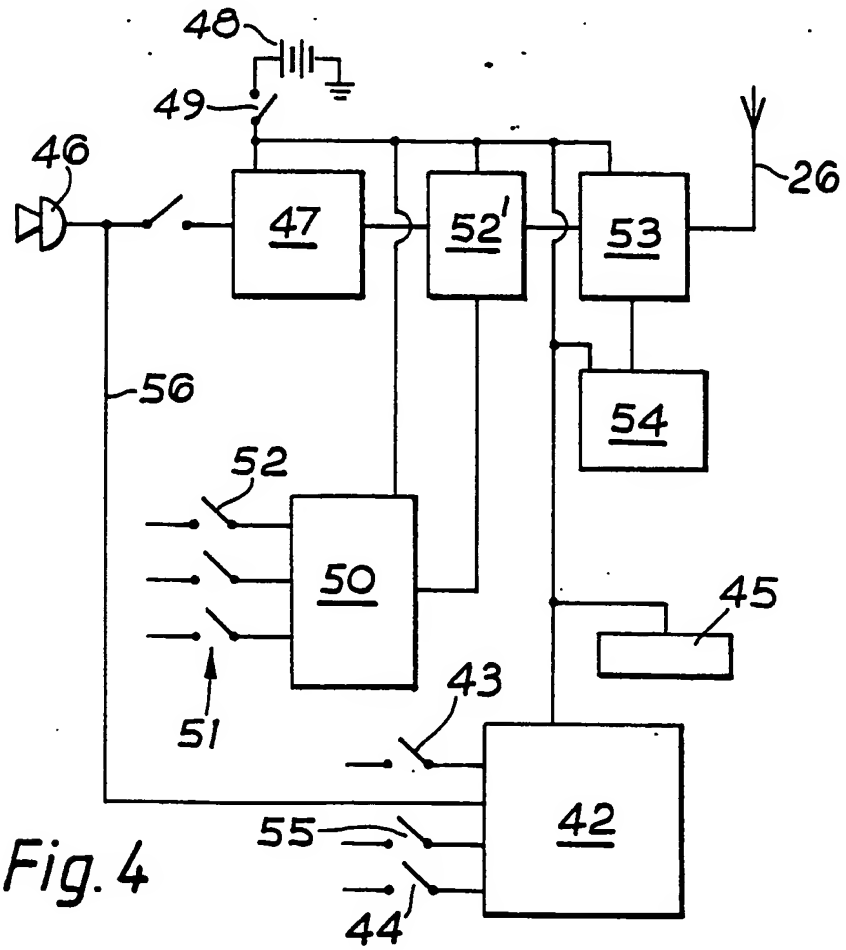
52
46


48
49
46
47
52'
53
26
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54
52
50
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51
43
42
55
44

Fig. 4

3/5

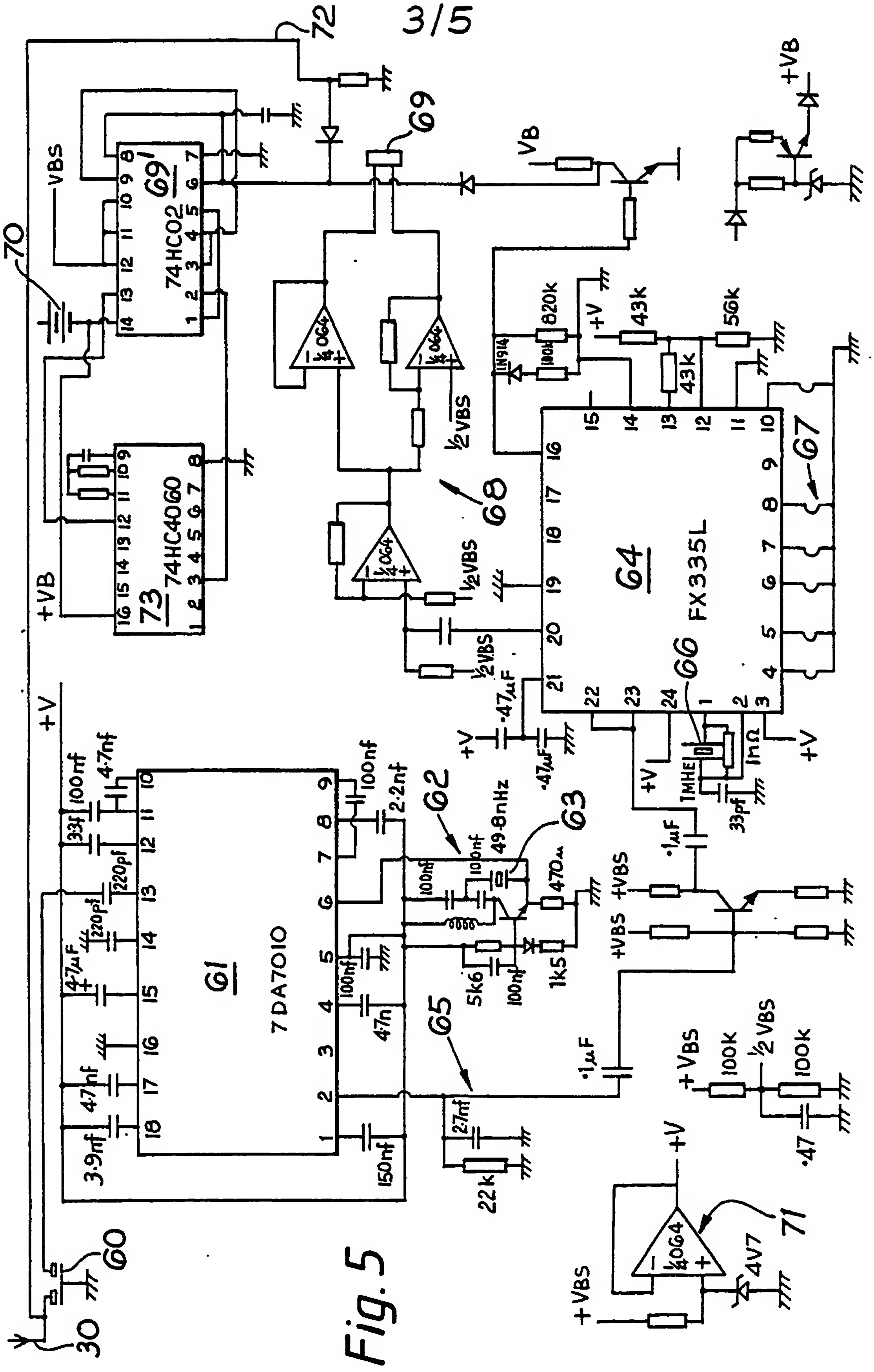
72
69
69'
74HC02
70
VBS
+VB
73
74HC4060
68
1/2 VBS
VB
1N914
820k
43k
56k
+V
64
FX335L
66
67
1MHz
33pf
1MΩ
61
7DA7010
62
63
49·8MHz
65
22k
100k
4V7
71
60
30

Fig. 5

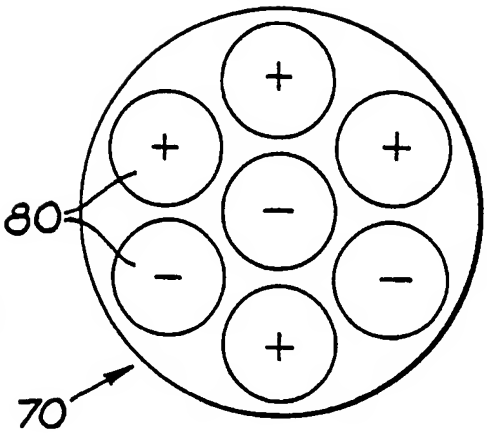

Fig. 6

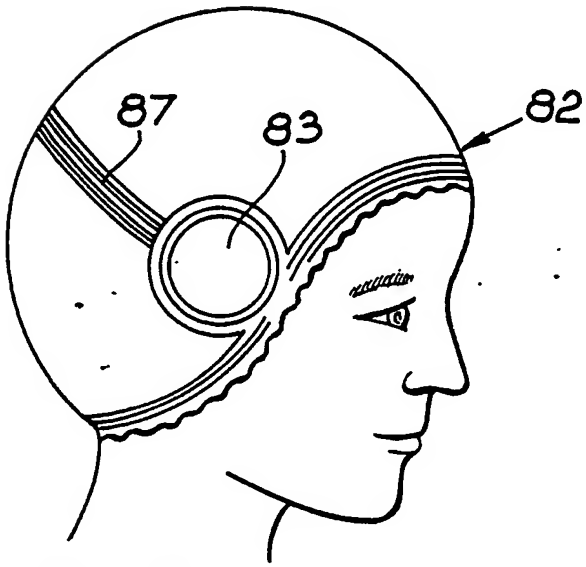

Fig. 7

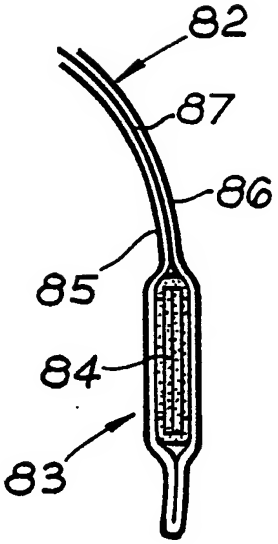

Fig. 8

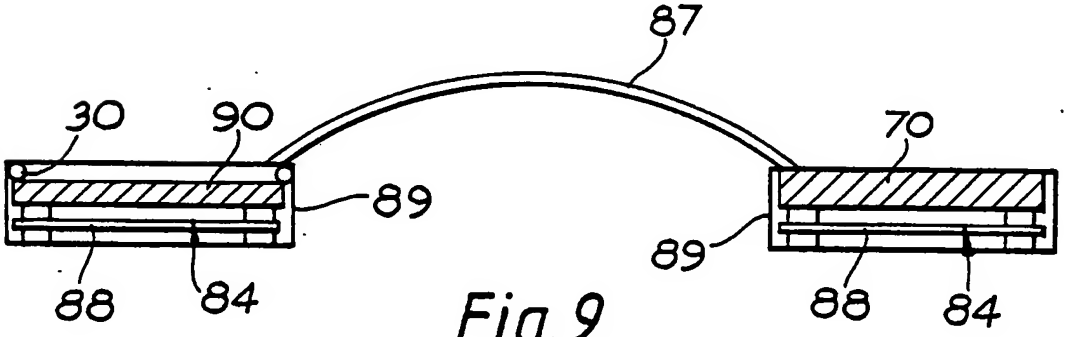

Fig. 9

Fig. 10

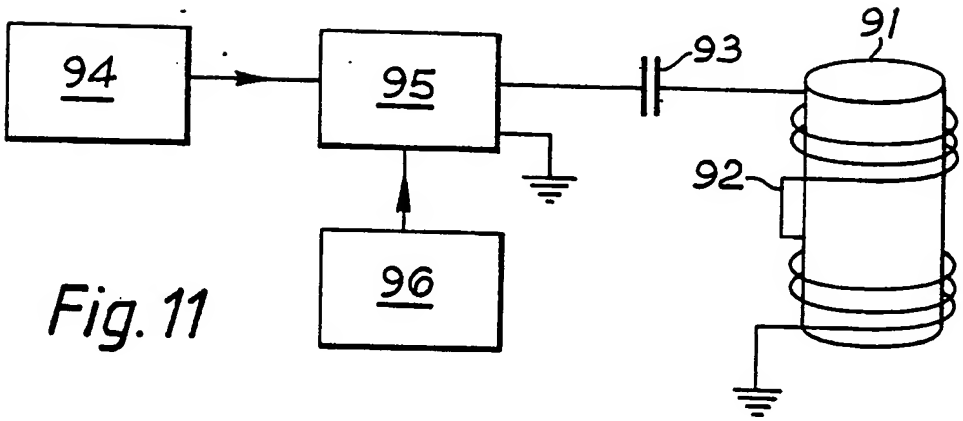

Fig. 11

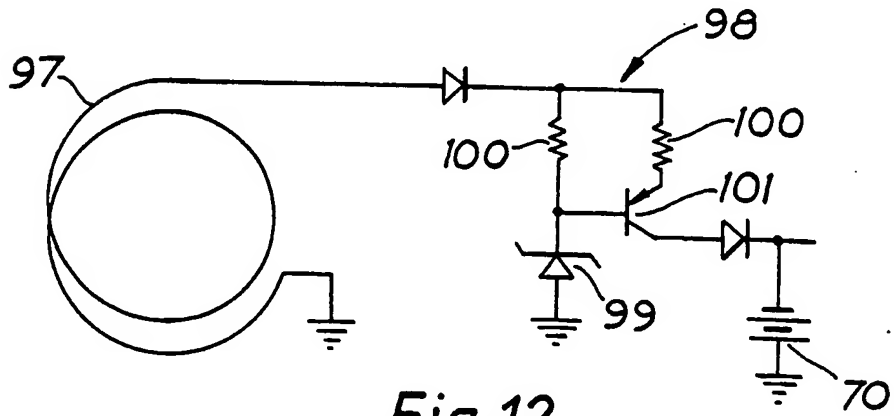

Fig. 12

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(81) Designated States: AT (European patent), AU, BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), SU, US.

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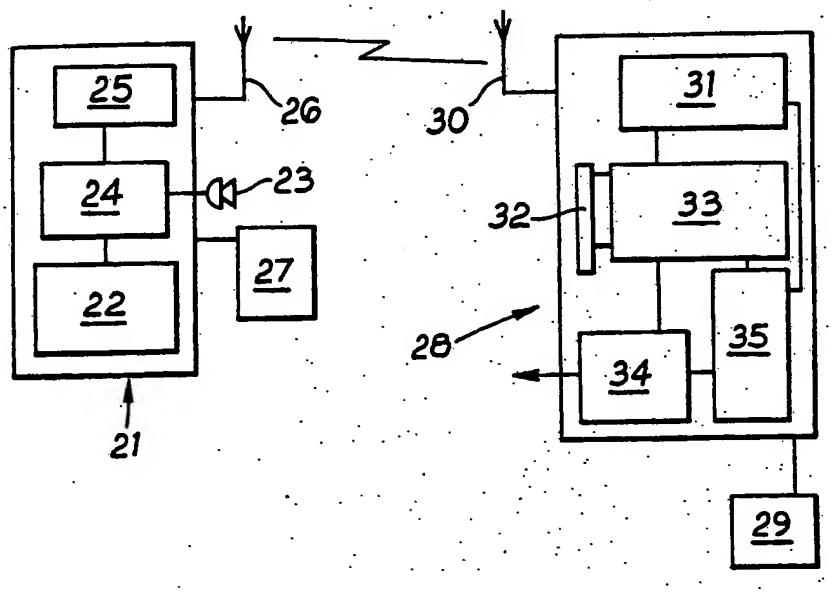
(54) Title: COMMUNICATION SYSTEM



(57) Abstract

A communication system especially for coaching swimmers comprises a hand set which the coach uses to summon up a swimmer or swimmers to be instructed by means of generated tones and a thing worn by each swimmer to be instructed which contains electronic amplifying means and audio transducers. To water proof the electronics they are enclosed in a sealed enclosure and then in the latex of a swimming cap. Batteries used in the circuitry can be recharged without breaking the sealing by using a strong magnetic field to break through the water-proofing and drive a constant current battery charging arrangement.

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INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 86/00762

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: A 63 B 69/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	A 63 B; H 04 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	DE, A, 2221767 (J. KLEINWÄCHTER) 15 November 1973, see figure; page 3, lines 8-12	1,3
Y		2
Y	DE, B, 1184252 (SIEMENS & HALSKE AG) 23 December 1964, see figure 1; column 1, lines 1-9	2
X	DE, A, 2817195 (E. BOTH) 31 October 1979	1

* Special categories of cited documents: [10]

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
16th March 1987	17 JUL 1987
International Searching Authority: EUROPEAN PATENT OFFICE	Signature of Authorized Officer: M. VAN MOL

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

V. [X] OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

This International search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. [X] Claim numbers 16-18 because they relate to subject matter not required to be searched by this Authority, namely:

See PCT Rule 6.2(a): Claims shall not, except where absolutely necessary rely, in respect of the technical features of the invention, on references to the description or drawings. In particular, they shall not rely on such references as:"as described in part..of the description" or 'as illustrated in figure... of the drawings".

2. [ ] Claim numbers....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. [ ] Claim numbers....., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. [X] OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

This International Searching Authority found multiple inventions in this international application as follows:

- claims: - 1,2,3 - 6-12
  - 1,4 - 13-15
  - 1,5

} See form PCT/ISA/206 dated 9th April 1986

1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. [ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. [X] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers: 1-3.

4. [ ] As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

[ ] The additional search fees were accompanied by applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/GB 86/00762 (SA 15538)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 29/06/87

The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A- 2221767	15/11/73	None	
DE-B- 1184252		None	
DE-A- 2817195	31/10/79	None	